REMARKS

This is intended as a full and complete response to the Office Action dated February 10, 2006, having a shortened statutory period for response set to expire on May 10, 2006.

CLAIMS

REJECTION UNDER 35 U.S.C. § 102

Claims 1 and 21 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,698,501 to Paske et al (*Paske*). Applicant respectfully traverses the rejection of claims 1 and 21.

Paske discloses a logging-while drilling (LWD) system for measuring formation density (see col. 1 lines 7-17, col. 3, lines 38-41). As taught by *Paske*, formation bulk density is obtained from a measure of *intensity* of backscattered radiation in the Compton energy range, commonly referred to as Compton radiation. Tool standoff introduces error in the bulk density measurement. The examiner cites col. 9 lines 21-32, Figs 2 and 7, and claim 1 in rejecting claims 1 and 21. Fig. 2 is simply a sectional view of the borehole tool. Fig. 7 (as well as Figs. 5 and 6) are illustrations related to effects of *tool standoff*. Lines 21-32 at col. 9 are directed toward correcting for tool *standoff*. *Paske* does *not* teach or suggest any means for adjusting or stabilizing the *gain* of the gamma ray detectors disposed within the logging tool. The specification of *Paske* is silent on detector gain adjustment. Furthermore, claim 1 of *Paske* as cited by the examiner is silent on any type of detector gain adjustment.

The instant LWD system is designed to measure elemental concentrations of natural gamma radiation in earth formation. Elemental concentrations are obtained from gamma ray energy spectra measured with the system's one or more gamma ray detectors. Accurate and precise concentration measurements require the gain of the gamma ray detectors be adjusted continuously and automatically during logging. Two methods of adjustment of detector gain for stabilization are disclosed in detail in the section entitled GAIN STABILIZATION. The first method is referred to as the "measured spectral analysis" method. The *slope* of the Compton scatter energy region 52 (see Fig. 5 and related discussion) varies as a function of temperature (see Fig. 6 and related discussion). Variations in temperature change detector gain (see Fig. 7 and related discussion). Therefore, a measure of the *slope* of the Compton scatter energy region can be used to determine a correction factor F_1 (see equation (1)) to adjust detector gain to a standard gain.

To summarize, *Paske* discloses a LWD density system. The instant system is a LWD natural gamma ray system. *Paske* uses a measure of *intensity* of Compton scatter radiation to determine formation bulk density. The instant invention uses a measure of the spectral *slope* of Compton scatter radiation to adjust detector gain. *Paske* is silent on detector gain adjustment, and addresses only the effects of tool standoff. Element (b) of instant claim 1 recites

(b) a first *adjustment of gain* of said detector is made using a measure of *slope* of a Compton scatter region of said spectrum.

Paske discloses no structure or methodology for adjusting detector gain. Element (b) of instant claim 21 recites

(b) making a first adjustment of *gain* of said detector using a measure of *slope* of a Compton scatter region of said spectrum.

Again, *Paske* is silent on gain adjustment and disclosed no structure or methodology for adjusting detector gain. Claims 1 and 21 are clearly distinguished over *Paske*. Applicant respectfully requests that the examiner reconsider rejection of claims 1 and 21 under 35 U.S.C. § 102(b) as being anticipated by *Paske*.

Claims 13, 33, 41 and 45 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,120,955A to Galford et al (*Galford*). Applicant respectfully traverses the rejection of claims 13, 33, 41 and 45.

Galford discloses a *wireline* natural gamma ray logging system. The system measures gamma ray energy spectra from naturally occurring radioactive elements found in a borehole environment. This measured energy spectrum is fitted to a plurality of standard spectra representing thorium (Th), uranium (U) and potassium (K). Fitting of measured spectra to standard spectra, and an initial tool calibration obtained using calibration "blocks" prior to logging, are used to obtain elemental concentrations of Th, U and K. More specifically, the system is initially calibrated to measured quantities of interest (Th, U, and K) *prior* to logging using the blocks that contain known amounts of Th, U and K (see col. 9 lines 47-50). The blocks are positioned *outside* of the logging tool. A gain correction circuit 305 (see col. 10, lines 13-16) adjusts the gain of measured natural gamma ray spectra based upon results of fitting of measured spectra to standard spectra.

The instant system is a *LWD* gamma ray logging system used to measure concentrations of Th, U and K. Here, however, any similarity ceases. The instant system uses a calibration source (preferably ^{241}Am) disposed *inside* of the logging tool near or within at least one detector assembly. This method of gain stabilization is disclosed in detail in the section Detector Source Gain Correction Method of the instant specification. The calibration source, being disposed within the logging tool, is used continuously throughout the logging operation to provide a means for correcting detector gain changes. The calibration source has nothing to do with calibrating the response of the system to *concentrations* of Th U, and K. The calibration source is used only for gain adjustment purposes. The dual gain circuit of the instant invention yields the same measured gamma ray spectrum, but with a standard gain and a high gain. The position of the peak structure from the calibration source in the high gain spectrum is used to generate a gain adjustment signal to correct the gain of the standard gain spectrum. Subsequently, quantities of interest (Th, U, and K) are determined from an analysis of the standard gain spectrum.

To summarize, *Galford* discloses a *wireline* natural gamma ray logging system. The instant invention is a *LWD* system that can be embodied to measure concentrations of naturally occurring radioactive materials in earth formations. The calibration of the *Galford* system to measure concentrations of K, U, and Th is accomplished using *blocks* containing known concentrations of these materials. The blocks are disposed *outside* of the tool prior to logging, and subsequently *removed* during logging. The instant system uses a detector calibration source to maintain a predetermined detector gain during logging. The detector calibration source is disposed *within* the logging tool and is used during logging as a means for automatically adjusting detector gain. The detector calibration source his *not* used to calibrate the system to absolute concentrations of Th, U and K. The "blocks" of *Galford* are in *no* way equivalent to the detector calibration source of the instant invention, as the examiner seems to imply at page 3, line 2 of the subject office action. The *Galford* system uses *gain correction* circuit 305 (see col. 10, lines 13-16) adjusts the gain of measured natural gamma ray spectra based upon results of fitting of measured spectra to standard spectra. The instant system uses a dual gain circuit that yields the *same* measured gamma ray spectrum, but with a standard gain and a high gain. The gain correction circuit 305 and the input spectral circuit 301 of *Galford* are in no way equivalent to the dual gain circuits of the instant invention, as the examiner seems to imply at page 3, line 4 of the subject office action. *Galford* does not teach or suggest a detector calibration source or a dual gain circuit disclosed in detail in the instant specification.

Regarding claim 13, the detector calibration source and the dual gain circuits are recited at elements (b) and (c), respectively. Regarding claim 33, the detector calibration source and the dual gain circuit are recited at elements (b) and (d), respectively. Regarding claim 41, the detector calibration source is recited at element (b). Regarding claim 45, the detector calibration source is recited at element (b). Claims 13, 33, 41 and 45 are clearly distinguished over *Galford*. In view of the above discussion, the examiner is respectfully requested to reconsider rejection of claims 13, 33, 41 and 45 under 35 U.S.C. § 102(b) as being anticipated by *Galford*.

Claims 49, 52, 53 and 56 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,698,501 to Hubner et al (*Hubner*).

Hubner discloses a wireline density logging system. The system comprises a cesium (^{137}Cs) source emitting 0.66 MeV gamma radiation and two axially spaced gamma ray detectors. A measure of Compton scatter radiation, induced by the cesium source, is used to determine formation bulk density. Detector assemblies 22 and 24 are disposed on articulating arms that are pressed against the wall of the borehole in order to minimize effects of material between the detector assemblies and the formation. The articulating arm methodology is totally useless in LWD systems, since the arms would be sheared off by the rotation of the tool. The position of a spectral peak at 0.66 MeV from the cesium logging source is used to maintain gain stabilization. A second source, namely ^{241}Am emitting gamma radiation at 60 KeV, is used in the *initial* gain calibration of the system. The ^{241}Am source is disposed near the tool prior to logging, and remove *before* logging (see col. 10, lines 58-66). The overall energy region of interest in the *Hubner* system extends from slightly below 60 KeV to slightly above 0.66 MeV.

The instant system is a LWD gamma ray logging system preferably embodied to measure naturally occurring radioactive elements Th, U and K emitting energy up to about 3 MeV. This energy range is significantly broader than the range used in the *Hubner* system.

Claims 49 and 53 have been amended to recite a gamma ray detector cooperating with a processor to yield a spectrum encompassing a range of about 3 MeV. Amended claims 49 and 53 are now distinguished over *Hubner*. Claim 52 depends on amended claim 49, which is distinguished over *Hubner*. Furthermore claim 52 recites at element (a) that the measured spectrum comprises gamma radiation from at least one naturally occurring radioactive element. *Hubner* is silent on measuring gamma radiation from naturally occurring radioactive elements. Claim 56 depends on amended claim 53, which is now distinguished over *Hubner*. Furthermore claim 56 also recites at element (a) that the measured spectrum comprises gamma radiation from at least one naturally occurring radioactive element. Once again, *Hubner* is silent on measuring gamma radiation from naturally occurring radioactive elements. Claims 52 and 56 are distinguished over *Hubner*. In view of the above discussion, the examiner is respectfully requested to reconsider rejection of claims 49, 52, 53 and 56 under 35 U.S.C. § 102(b) as being anticipated by *Hubner*.

REJECTION UNDER 35 U.S.C. § 103

In order to establish a case of *prima facie* obviousness, three basic criteria must be met:

1. There must be some suggestion or motivation, either in the reference(s) themselves or in the knowledge, generally available to one of ordinary skill in the art, to modify the reference(s) or to combine the reference teachings;
2. There must be a reasonable expectation of success; and
3. The prior art must teach or suggest all of the claim limitations. The teachings or suggestions to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in the applicant's disclosure.

Claims 2-11 and 22-31 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Paske* as applied to claim 1, and further in view of *Hubner*. Claims 2-11 and 22-31 depend on claims 1 and 21, respectively. Applicant respectfully traverses the rejection of claims 2-11 and 22-31.

As discussed at length above, both *Paske* and *Hubner* are systems for determining *formation density* from measures of *intensity* of Compton scatter radiation.

1. There is no motivation for one of ordinary skill in the art to combine two *formation density* systems (with the *Hubner* being a wireline density system inoperable as a LWD system) to form a LWD natural gamma ray system of the instant invention.

2. As discussed above, the *Hubner* system would be inoperable as a LWD system.

3. Neither the *Paske* nor the *Hubner* systems teaches or suggest the element (b) of independent claims 1 and 22 wherein the *slope* of the Compton scatter region is used to adjust detector *gain*.

A combination of *Paske* and *Hubner* fails all three criteria for establishing *prima facie* obviousness regarding the independent claims 1 and 21. Dependent claims 2-11 and 22-31 are therefore clearly patentable over *Paske* in view of *Hubner*. The examiner is respectfully requested to reconsider rejection of claims 2-11 and 22-31 under 35 U.S.C. § 103(a) as being unpatentable over *Paske* as applied to claim 1, and further in view of *Hubner*.

Claim 12 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Paske* and *Hubner* as applied to claim 6, and further in view of U.S. Patent No. 4,612,439 to Chance et al (*Chance*). Applicant respectfully traverses the rejection of claim 12.

Chance discloses a wireline natural gamma ray logging system for determining elemental concentrations of Th, U and K. *Chance* is silent on any type of detector gain stabilization.

As stated above, there is no motive to combine *Paske* and *Hubner*. Furthermore, there is no reasonable expectation that a combination of *Paske* and *Hubner* would be operable, since *Hubner* is a wireline device with articulating arms completely unsuitable for LWD applications. Any combination of *Paske* and *Hubner* with the addition of *Chance* would lack the element (b) of claim 1, since all are silent on using the *slope* of the Compton region as a means for *adjusting gain*. When one considers all additional elements recited in claim 6 and the intervening claims, and further considers additional intervening elements recited in rejected in claim 12, it is apparent that a combination of *Paske* and *Hubner* and *Chance* will not meet *any* of the previously stated criteria of *prima facie* obviousness. The examiner is respectfully requested to reconsider the rejection of claim 12 under 35 U.S.C. § 103(a) as being unpatentable over *Paske* and *Hubner* as applied to claim 6, and further in view of *Chance*.

Claims 14 and 17-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 13, and further in view of U.S. Patent No. 5,600,135A to Jacobson et al (*Jacobson*). Applicant respectfully traverses the rejection of claims 14 and 17-18.

Jacobson discloses a wireline gamma ray logging tool. Detector gain stabilization is maintained by adjusting detector voltage to maintain a predetermined ratio between two energy windows. *Jacobson* does not teach the use of a detector calibration source as a means for adjusting gamma ray detector gain. *Jacobson* does not teach the use of a dual gain circuit, as disclosed in the instant specification, for adjusting gamma ray detector gain.

There is no motive to combine wireline gamma ray logging systems of *Galford* and *Jacobson* to obtain the instant LWD system. There is no reasonable expectation that a combination of *Galford* and *Jacobson* would be operable, since neither, *as disclosed*,

addresses any problems encountered in the LWD environment. Finally, any combination of *Galford* and *Jacobson* would not yield or suggest the claimed elements of the instant claims under rejection, including a gain stabilization source and dual gain circuitry. A combination of *Galford* and *Jacobson* will not meet *any* of the previously stated criteria of *prima facie* obviousness. The examiner is respectfully requested to reconsider the rejection of claims 14 and 17-18 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 13, and further in view of *Jacobson*.

Claims 15-16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 13, and further in view of *Paske*. Applicant respectfully traverses the rejection of claims 15-16.

There is no motive to combine wireline gamma ray logging system of *Galford* with the LWD density logging system of *Paske*. There is no reasonable expectation that a combination of *Galford* and *Paske* would be operable. *Paske* addresses LWD logging problems (i.e. standoff in particular) related to density logging. *Galford* addresses wireline logging problems (i.e. spectrum fitting, precision and accuracy versus logging speed) associated with natural gamma ray logging. Neither reference addresses any problems encountered in the LWD natural gamma ray logging. Once again, any combination of *Galford* and *Paske* would lack claimed elements of the instant claims under rejection, including a gain stabilization source and dual gain circuitry. A combination of *Galford* and *Paske* will not meet *any* of the previously stated criteria of *prima facie* obviousness. The examiner is respectfully requested to reconsider the rejection of claims 15 and 16 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 13, and further in view of *Paske*.

Claims 19-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* and *Jacobson* as applied to claim 17, and further in view of *Paske*. Applicant respectfully traverses the rejection of claims 19-20.

There is no motive to combine wireline gamma ray logging system of *Galford* with the LWD density logging system of *Paske* and the wireline natural gamma ray logging system of *Jacobson*. There is no reasonable expectation that a combination of *Galford* and *Paske* and *Jacobson* would be operable. Only *Paske* discloses a LWD system, and the system is a *density* logging system. As a result, *Paske* addresses only density related LWD problems such as tool standoff and the correction thereof. *Galford* and *Jacobson* address only wireline logging problems (i.e. spectrum fitting, precision, accuracy versus logging speed detector gain stabilization in a wireline system) associated with natural gamma ray logging. None of the references addresses any problems encountered in the LWD natural gamma ray logging. Furthermore, any combination of *Galford* and *Paske* and *Jacobson* would lack claimed elements of the instant claims under rejection, including a gain stabilization source and dual gain circuitry. A combination of *Galford* and *Paske* and *Jacobson* will not meet *any* of the previously stated criteria of *prima facie* obviousness. The examiner is respectfully requested to reconsider the rejection of claims 19-20 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 17, and further in view of *Paske*.

Claim 32 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Paske* and *Hubner* as applied to claim 29, and further in view of *Chance*. Applicant respectfully traverses the rejection.

The rejections of claims 22-31 as being unpatentable over *Paske* as applied to claim 1 and further in view of *Hubner* are discussed above and argued that criteria of *prima facie* obviousness are not met. The addition of *Chance* to the combination does not meet criteria for *prima facie* obviousness. More specifically, the addition of *Chance* adds no motive, since *Chance* discloses a wireline system. The addition of *Chance* does not increase the chances of success of the combination, since *Chance* addresses no LWD logging problems. Finally and most convincingly, the addition of *Chance* yields a combination that still lacks all of the claimed elements of the independent claim 21 and all intervening claims, including element (b) of claim 21 which recites the use of the *slope* of the Compton scatter region of the spectrum to adjust detector gain. The examiner is respectfully requested to reconsider rejection of claim 32 under 35 U.S.C. § 103(a) as being unpatentable over *Paske* and *Hubner* as applied to claim 29, and further in view of *Chance*.

Claims 34 and 37-38 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 33, and further in view of *Jacobson*. Applicant respectfully traverses the rejection.

Independent claim 33, from which claims 34 and 37-38 depend, recites a detector calibration source at element (b) and dual gain circuitry at element (d). Considering the repeated discussion of *Galford* and *Jacobson* references, it will summarized (in view of previous discussions above) that no combination of *Galford* and *Jacobson* will meet any of the criteria of *prima facie* obviousness, including the lack of the elements (b) and (d). The examiner is respectfully requested to reconsider rejection of claims 34 and 37-38 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 33, and further in view of *Jacobson*.

Claims 35-36 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 33, and further in view of *Paske*. Applicant respectfully traverses the rejection.

Independent claim 33, from which claims 35-36 depend, recite a detector calibration source at element (b) and dual gain circuitry at element (d). Again in view of the repeated discussion of the *Galford* and *Paske* references, it will summarized (see discussions above) that no combination of *Galford* and *Paske* will meet any of the criteria of *prima facie* obviousness, including the lack of the elements (b) and (d). The examiner is respectfully requested to reconsider rejection of claims 35-36 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 33, and further in view of *Paske*.

Claims 42-43 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 41, and further in view of *Hubner*. Applicant respectfully traverses the rejection.

Independent claim 41, from which claims 42-43 depend, recites a detector calibration source at element (b). In view of the repeated discussion of the *Galford* and

Hubner references, it will summarized (see discussions above) that no combination of *Galford* and *Hubner* will meet any of the criteria of *prima facie* obviousness, including the lack of a detector calibration source recited in element (b). The examiner is respectfully requested to reconsider rejection of claims 42-43 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 41, and further in view of *Hubner*.

Claim 44 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* and *Hubner* as applied to claim 42, and further in view of *Paske*.

In view of the discussion of the rejection of claim 42 above, the addition of *Paske* to a combination of *Galford* and *Hubner* will not meet any criteria of *prima facie* obviousness which are (1) motive to combine, (2) reasonable chance of success, or (3) yield or suggest all claimed elements, including the detector calibration source recited at element (b) of claim 41. The examiner is respectfully requested to reconsider rejection of claim 44 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* and *Hubner* as applied to claim 42, and further in view of *Paske*.

Claims 46-47 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 41, and further in view of *Hubner*.

Claims 46-47 depend upon independent claim 45, although the examiner rejects the claims as applied to claim 41. Using either claim 45 or 41, grounds for rejection of claims 46-47 fail to meet any criteria of *prima facie* obviousness which are (1) motive to combine, (2) reasonable chance of success, or (3) yield or suggest all claimed elements including elements (b) recited in claim 41 or in claim 45. The examiner is respectfully requested to reconsider rejection of claims 46-47 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* as applied to claim 41 (45), and further in view of *Hubner*.

Claim 48 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Galford* and *Jacobson* as applied to claim 45, and further in view of *Paske*. Applicant respectfully traverses the rejection.

For brevity and in view of previous discussion of the references, it will simply be stated that any combination of *Galford* and *Jacobson* and *Paske* will lack the detector calibration source element recited at element (b) of independent claim 45. The criteria for *prima facie* obviousness are, therefore, not met. The examiner is respectfully requested to reconsider rejection of claim 48 under 35 U.S.C. § 103(a) as being unpatentable over *Galford* and *Jacobson* as applied to claim 45, and further in view of *Paske*.

Claims 50-51 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Hubner* as applied to claim 49, and further in view of *Paske*.

Claim 50 recites that at least one detector is disposed in a detector channel at the *periphery* of a collar. Claim 51 recites that two or more detectors are disposed around the *periphery* of the collar. This aspect of the invention optimizes detector response, as is discussed in detail in the specification. Fig. 2 of the *Paske* reference clearly shows that the detectors 52 and 53 are positioned in channels cut into the *inside diameter surface* of the collar. The disadvantages of the *Paske* embodiment are overcome by the detector

positioning of the instant invention, as claimed in claims 50 and 51. No combination of *Hubner* and *Paske* will yield one or more detectors disposed at the *periphery* of the collar. Claims 50 and 51 are clearly patentable over *Hubner* in view of *Paske*. The examiner is respectfully requested to reconsider rejection of claims 50-51 under 35 U.S.C. § 103(a) as being unpatentable over *Hubner* as applied to claim 49, and further in view of *Paske*.

Claims 54-55 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Hubner* as applied to claim 53, and further in view of *Paske*.

Claim 54 recites disposing at least one detector in a detector channel at the *periphery* of a collar. Claim 55 recites disposing two or more detectors around the *periphery* of the collar. As discussed above, this aspect of the invention optimizes detector response, as is discussed in detail in the specification. Once again, it is noted that Fig. 2 of the *Paske* reference clearly shows that the detectors 52 and 53 are positioned in channels cut into the *inside diameter surface* of the collar. No combination of *Hubner* and *Paske* will yield one or more detectors disposed at the *periphery* of the collar. Claims 54 and 55 are clearly patentable over *Hubner* in view of *Paske*. The examiner is respectfully requested to reconsider rejection of claims 54-55 under 35 U.S.C. § 103(a) as being unpatentable over *Hubner* as applied to claim 53, and further in view of *Paske*.

SUMMARY

In view of the above discussion, the Examiner is respectfully requested to reconsider all rejections and allow claims 1-56.